PLANT

POPULAR SCIENCE BOOKLET SERIES

PLANT

Author: Dong Baohua
Translator: Yao Bijun
Jing Yuxiang

FROM THE EDITOR

Plants are very important for human existence. Along with the advancing of modern science and technology, the research work and the utilization of plants are also progressing. This booklet revealed the secrets of the cells of a plant and described systematically the roots, stems, leaves, flowers, seeds and fruits. Indigenous plants in China were introduced in the last part. As it is well illustrated and easy to understand, this booklet is suitable for readers of junior middle school educational level.

PLANT is one of the "Popular Science Booklet Series" which has a total of twelve booklets, namely: Mechanism, Sound, Heat, Electricity, Air and Water, Light, Astronomy, The Earth's Crust, Meteorology, Animal, Plant and Hygiene.

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CHAPTER I

THE WORLD OF PLANTS

1 The Hero of Drought Tolerance and the Good Diver

Have you ever seen the cacti? They are the heroes of drought tolerance. There are more than 2,000 species in the plant kingdom, with the desert area of subtropic as their homeland. They have developed a special ability to adapt drought due to scarce rainfall over there. But how great is this ability after all? A big wislizen echinocactus (Echinocactus wislizenii Engelm) weighing 37.5 kg. was placed in a room without supply of water for six years. It was surprising to find that the plant was still alive and weighed 26 kg. That is to say, it only lost 11 kg. of water in those six years. Why can cacti (Fig. 1) tolerate drought to such a high degree? An answer to this question is that the long term of desert life had changed remarkably the plant structure and function, e.g. their leaves have reduced to spines so as to decrease water loss through transpiration; their stems are thick and fleshy to store a large amount of water and the surfaces of their stems have developed a thick cuticle to prevent water from escaping. In fact, cacti are not the only plants that can exceedingly endure drought. Some other plants such as Ephedra sinica, Cynomorium songaricum, two famous

Chinese herbs, are most capable of drought-enduring, too. They can all adapt to the environment of desert area.

Fig. 1 Cacti

In summer when we swim in ponds or rivers, we will often meet waterweeds like hornwort (Ceratophyllum demersum), bladderwort (Utricularia vulgaris), pondweed (Potamogeton distinctus), Hydrilla verticillata and Vallisnera spiralis (Fig. 2). Generally, they live in the depth of 2-3 m of water, and even in still deeper water of 20-30 m below the level, if it is very clean. They are good divers as they can spend their whole lives submerging in water. Why can they do so? It is because the long term life in water makes them adaptable to the environment by means of many characteristic structures, i.e. the leaves of

waterweeds have become narrow and small or lobbed so as to reduce the resistance to water; the well-developed air passages favour gas flow and exchange as well as increase their buoyancy; the capability of absorption by the overall plant surfaces enable them to absorb water and nutrients directly from their surrounding. In fact, the divers occur also in a great number in the ocean not just in such fresh water as ponds and rivers. The kelp, laver we often eat are submerged plants (Fig. 3). There is still a species of red algae in the ocean that can live in two hundred meters below the sea level.

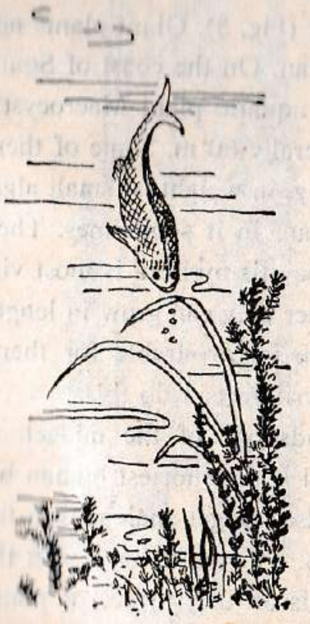

Fig. 2 Watergrass

***Fig. 3** Kelp*

2 The Giant and the Tiny

Talking about the giant, there had been an American measured 2.72 m. He is considered as the tallest man in the world. In the plant kingdom, however, there are numerous giants. A tree called Parachorea chinensis var. Kuangsiensis was found in counties like Longzhou and Bama of Guangxi Province of China some years ago. It is as high as a building with twenty floors of over sixty-five meters in height. In Mt. Neveda of California, USA, there lives a big tree named sierra bigtree (Sequoiadendron giganteum) (Fig. 4). It can reach 142 m in height and 12 m in diameter. If the trunk is tunneled through, cars may pass freely, and if the tree is cut down one can reach the trunk only by the help of a ladder (Fig. 5). Giant plants not only exist on land but also in the ocean. On the coast of South Africa and Australia, there lives an aquatic plant Macrocystis pyrifera (Fig. 6). Their length is generally 60 m. Some of them may reach 100 m in length and 180 kg. in weight. A small alga-collecting boat can only load one plant in it sometimes. They really are the "King of algae". Macrocystis pyrifera is most vigorous in growth. In spring and summer they can grow in length of 1 m when the water temperature is favourable for them. There is no plant but Macrocystis pyrifera can do this.

Speaking of the tiny, it reminds one of the midget. A woman of only 59 cm tall in Holland is the shortest human being known in the world. There are also midget analogues in the plant kingdom. They are little tinies. You must have seen the small and round pieces of duckweeds on the surface of ponds or small rivers in summer. The duckweed plant has only a

small thallus and a fine root floating on the water (Fig. 7). The smallest flowering plant in the world looks like duckweed very much. It has one fourth the size of the latter and is native to the tropic. It is called Hoffia arrhiza. The bacteria which are well-known to us belong to plants, too. They are even much smaller. For example, Mycobacterium tuberculosis causing tuberculosis can pass the hole of a very small needle when they are transversely lined together by 2,000—4,000 in number.

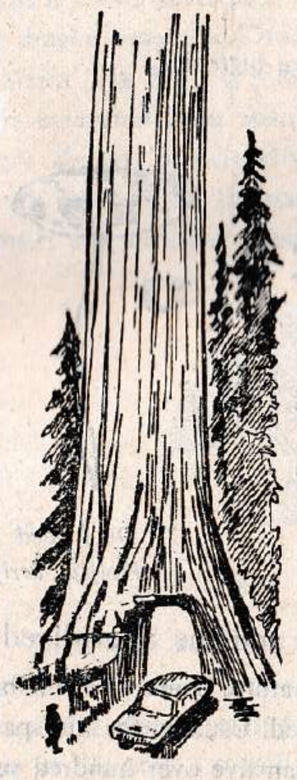

Fig. 4 Sierra bigtree (Sequoiadendron giganteum)

Fig. 5 A cut sierra bigtree

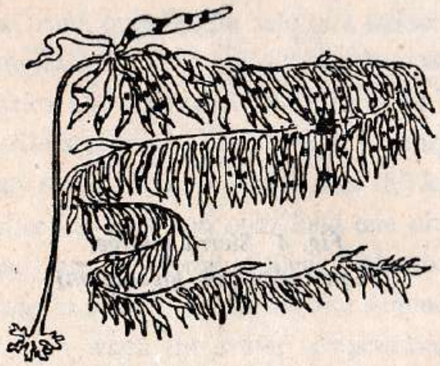

Fig. 6 Macrocystis pyrifera

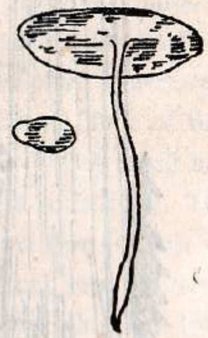

Fig. 7 Duckweed and Holffia arrhiza

3 The God of Longevity and the Short-lived

There are various plants in nature, some of them being long lived and some being short lived. Usually, the life span of trees is longer and many of them can live over hundred years.

Among them vines can extend their life to one hundred years, apple trees to two hundred years, pears to three hundred years, Japanese pagodatree (Sophora japonica) to five hundred years, poplars to six hundred years and Chinafir (Cunninghamia) to one thousand years. Chamaecyparis taiwanicola in Ali Mountain of Taiwan Province is known to have the longest life. It has hitherto lived three thousand years. It is said that the Juniperus chinensis in Qufu of Shandong, the native place of Confucius is 2,400 years old. The longest life of tree in the world is a dragon dracaena (Dracaena draco) living in isles canarias of Africa (Fig. 8). It is said that the tree lived more than 8,000 years measured by a Spaniard about 500 years ago. Unfortunately, the god of longevity died of a windstorm in nineteenth century. Since then, the native people has made many kinds of utensils as a birthday present for long life.

Fig. 8 Dracaena draco

There also are many short lived plants in nature. For example, the spring wheat can only live to be three months. A leguminous plant growing in Plateau Paimier of China maintains its life only a month or two from germination to flower-

ing as the summer there is very short. The shortest lived flowering green plant is a species of Chrysanthemum which grows in the desert. They can go through from seed to seed in several weeks before severe drought comes.

CHAPTER II

THE SECRET OF CELLS

1 Who Reveals the Secret

Earlier before the Christian era there was a well-known Greek scientist by the name of Aristotle who was good at researches on philosophy and biology. He said that whatever complex the plants will be, they are all composed of several essential elements. He meaned the essential elements as the common organs of most of plants, e.g. roots, stems, leaves and flowers. This is the earliest explanation to the plant structure. What are these organs composed of then? It remained as a mystery for a long time.

In 1665, an English physicist Robert Hooke was able to make a microscope of 270 magnification power and he observed the thin sections of cork under it (Fig. 9). He found that the cork consisted of many little "boxes". So, the term "cell" was first used by him to denote the "little boxes" or cells in cork (Fig. 10). In fact, what he saw then were no more than the frame of cork cells — cell walls. But Hooke's discovery opened a new era for the observation of plant structures. Men began to know the internal structure of plants which can't be seen with naked eyes. Since then there have been many scientists working on cell structures. They have gradually enriched

our knowledge of cells through their observation of countless materials with microscope. For example, in 1671 an English man Grew and an Italian Malpighi independently found the sticky substance in cells. In 1831 an English scientist Robert Brown found that there was an even stickier spherical structure in the sticky substance. In 1838 — 1839 the German zoologist Theodor Schwann and the Belgian botanist Matthias Jacob Schleiden established the cell theory, pointing out that the cell was the basic unit of all organisms. Although 174 years had passed from the year 1665 when the secret of cells was revealed to the year 1839, it was just the beginning for cell research. In recent decades with the invention of electron-microscope as well as the influences of physics and chemistry on biology, the knowledge of cells has been deepened to molecular level.

Fig. 9 Robert Hooke's microscope

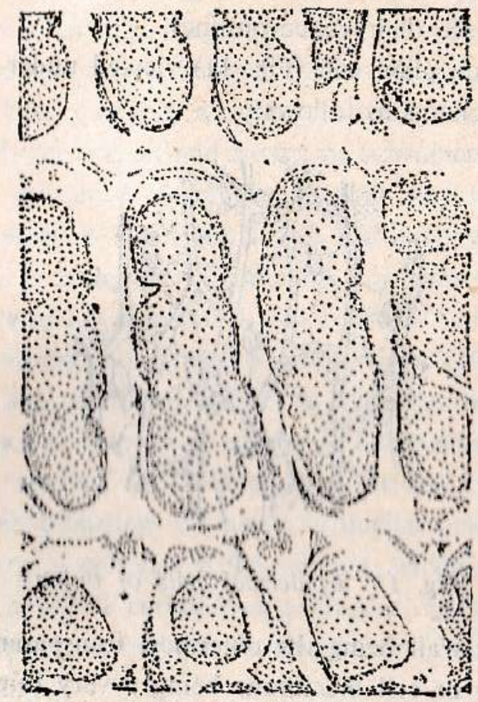

Fig. 10 A thin section of cork under microscope

2 Plant Cells Under Microscope

As a high building laid by bricks one by one, a green flowering plant is composed of thousands of thousands of cells. These are called plant cells. They vary with plants in size and form as well as function, but they have a fundamentally similar structure. The plant cells are very small with 20 — 100 μ in length (1μ = 1/1,000 mm) and can't be seen with naked eyes.

Even if the microscope of more than 60 magnifications is used, one can only see their vague outlines.

A common plant cell (Fig. 11) viewed under microscope has the components as follows:

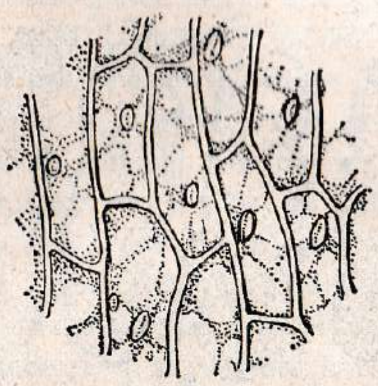

Fig. 11 Epidermal cells of onion

The cell wall being the outermost transparent layer; the plasmolemma or cell membrane being a very thin and undistinguished membrane beneath the wall; the cytoplasm being a colourless transparent sticky substance covered by the plasmolemma; the nucleus being an even stickier spherical structure in cytoplasm; the vacuole being the sac-like structure with colourless transparent sap in them. The sap which is a kind of solution. There are different solutes dissolved in the cell sap of different plants. When we cut a water melon in summer, much sap will flow out from the cut surfaces. The sap comes out of the broken vacuoles. Owing to much sugar in the cell sap of water melon, it tastes sweet.

Having learned the cell structures, certainly you want to know eagerly what roles they play in the cell. The cell wall is in charge of supporting and protecting the cell as it is in the outmost layer. The cytoplasm attaching to the wall, like the customs, controls the import and export of substances, preventing both useful substances from flowing out and harmful ones from being taken in. The cytoplasm is highly complex in structure. When it is examined with the electron microscope magnifying as many as ten thousand times, one may see it consisting of many "little organs" with special functions. Some of these little organs can absorb or synthesize nutrients, and some can supply energy for various cell activities. The genetic controlling center is the nucleus which determines the cell types and the shapes of their offsprings by means of nucleic acid. There is a certain amount of cell sap in the vacuole, which can not only maintain the cell with certain shape but also regulate the water content in the cell. It may be visualized therefore, that the cell is a living thing.

3 Cell Division and Cell Growth

Various plants in nature have a common character of growing step by step from small to large, in addition to their general composition of cells. Why can they grow then? Their growth results from continuous cell divisions and cell growth.

Cell division (Fig. 12) is the only way to reproduce cells. Although cell division is a very complex process, simply, it is a process of "one dividing into two" and "two dividing into four". When cell divides, the first thing to occur goes to the nucleus

which separates itself into two equal halves. And then, the cytoplasm divides into two equal parts. New cell wall appears in the middle of the former cell. The cells newly divided are relatively small. Later on they grow gradually as a result of nutrient absorbed from their environment. The growth stops after a certain size is reached.

All small cells in plant can grow up gradually, but not all of them are able to divide. Generally, the cells capable of division have fixed positions, they are located at shoot tips and root tips as well as the internodes of young stems of wheat and maize. You may have heard of the maize stalk making the sound "ga-ga" at night during its bolting stage. The sound is just caused by the active cell division and cell growth at the internodes.

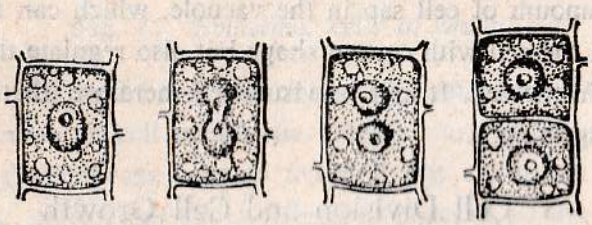

Fig. 12 Cell division

CHAPTER III

SEEDS OF PLANTS

1 Seeds of All Forms

A great number of plants in nature surrounding us propagate themselves by means of seeds. Seeds of plants are in various size. Talking about the small ones, sesame is the best-known example which are often likened to small. A sesame seed weighs only 3/1,000g. It's really small. But there are many seeds still smaller than it, for example, a tobacco seed weighs 1/7,000g. The plant with smallest seeds in the world goes to goodyera. The goodyera plants grow on shady and wet slopes in South China and their seeds consist of tens of cells of hundreds microns in length. Each seed weighs 1/2,000,000g. Mentioning the bigger seeds, it possibly reminds you of broadbean (Vicia faba) which is much bigger than sesame. A seed of broadbean possesses a weight of 2.6g, 1,000 times as weighty as that of sesame. There is, however, even still a seed weighing 5,700 times of a bean seed. Date palm (Fig. 13), a plant living in the archipelago of Seychelles has its seeds weighing 15,000g each. They are really the biggest seeds in the world.

The shape and colour of the seed of various plants differ widely. The pea (Pisum sativum L.) seed which we often see is spherical. The seed of kidney-bean (Phaseolus vulgaris) is kid-

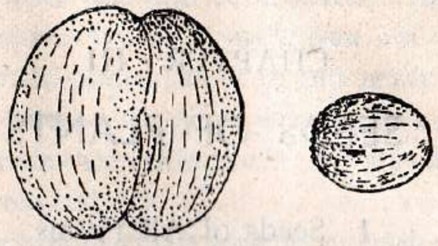

Fig. 13 Date palm compared with coconut

ney-shaped, and the seed of teaplant is triangular. Concerning the colour, there are red, white, green, yellow and black as well among legume seeds alone. We know now that about two hundred thousand plant species on earth can produce seeds, which amount to two third of the whole plant kingdom. What a big seed family! How diverse it is!

2 Bean Seed and Maize Grain

Despite of the differences in size, shape and colour of plant seeds, they are basically similar in structure. If you don't believe it, just examine the seeds of (kidney-) bean and maize.

The bean seed (Fig. 14) is covered with a tough and tensile seed coat. On the seed coat where the seed is sunken, there is a scar called hilum, much like a navel, left where the seed shedded from the pod. After the seed coat of a soaked bean is removed, the two halves of bean which attach to each other are then exposed. They are known as cotyledons (seed leaves). Storing a great quantity of nutrients, the cotyledons are very thick. If you separate them from each other, you will see three

portions: the plumule bearing minute leaves; the radicle being the pointed part and the last portion embryonic axis connecting the plumule, the radicle and the cotyledons. The plumule is the future shoot and the radicle is the future root. The embryonic axis will develop into the part connecting the stem with the root. The whole structure consisting of the plumule, radicle, embryonic axis and the cotyledons is called the embryo. The kidney bean seed involves the seed coat and the embryo. The seed coat covers and protects the embryo. Capable of growing into a new plant, the embryo is the main portion of the seed.

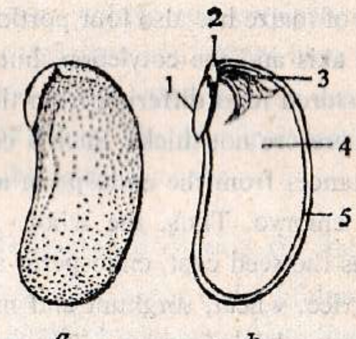

Fig. 14 Seed of kidney bean

a-external appearance; b-internal structure
1-radicle; 2-embryonic axis; 3-plumule; 4-cotyledon; 5-seed coat

Just like the seed of kidney bean, seeds of soybean, cotton, tomato, apple, cucumber and many other plants have also seed coats and embryos. All of these embryos have two cotyledons.

The plants possessing two cotyledons in a seed are named dicotyledonous plants (dicot).

When we cut a soaked maize grain along the dotted line as Fig. 15, a thick cover will be recognized. The outer layer of this cover is called pericarp, which corresponds to outer skin of a bean pod, and the inner layer is called seed coat, which corresponds to the outer skin of the bean seed. The pericarp and the seed coat of maize grain are integrated with each other too closely to be separated. So, a maize grain corresponding to a pod of legume plants is in reality a fruit. But we usually call a maize grain seed. Inside the seed coat is a structure mainly of food storage known as the endosperm. The embryo is just below it. The seed of maize has also four portions: the plumule, radicle, embryonic axis and the cotyledon, but it has only one cotyledon without stored food differing from that of bean seed. The cotyledon is therefore not thick. Such a cotyledon can absorb nutrient substances from the endosperm and convey them to the developing embryo. Thus, the whole structure of the maize seed contains the seed coat, endosperm and the embryo.

The seeds of rice, wheat, sorghum and many others have the same structure as that of maize. The embryos of these seeds have one cotyledon only, and the plants having embryos like maize are said to be the monocotyledonous plants (monocot).

Having examined the seeds of kidney bean and maize, we have understood that seeds of different plants are of the same basic structure with embryos and their nutritive materials as well as seed coats. All embryos have four portions: the plu-

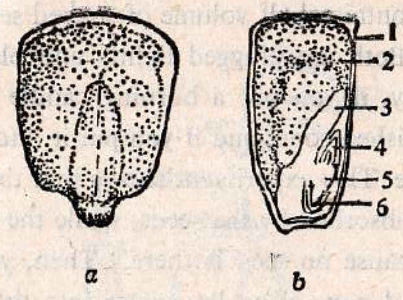

Fig. 15 The maize grain

a-external appearance; b-longitudinal section
1-pericarp and seed coat; 2-endosperm; 3-cotyledon; 4-plumule; 5-embryonic axis; 6-radicle

mule, embronic axis, radicle and cotyledon(s). But some embryos have two cotyledons and others have one. The nutrient of seeds are stored in the cotyledons in one case, and in the endosperms in the other. The principal nutrients stored in the seeds are starch, proteins and fats.

3 Reasonable Needs of the Seed

Seeds in the granary seem to be lifeless, but they are actually alive, and their physiological activities are simply very weak. If they are in suitable conditions, the seeds will regain their vigour. The embryos start to grow with their radicles bursting through seed coats, and will gradually become seedlings. The seed thus needs certain prerequisites for germination, i.e. air, water and favourable temperature.

Why is air needed by seed germination? An experiment will make reply. Two bottles, a and b, are to be prepared (Fig.

16). Bottle a contains half volume of soaked seeds and bottle b is left vacant. Both are plugged tightly and placed in a warm place. Next day, if you put a burning candle into bottle a, it will be extinguished soon, and if you put it into bottle b, it will still be in flame. This experiment shows that the oxygen in bottle a has been absorbed by the seeds, while the oxygen in bottle b has not, because no seed is there. Then, you set up bottle a as Fig. 17 and pour clean limewater into the test-tube, pour water into funnel. What is happening? There are air bubbles produced continuously in the limewater which will become turbid soon. Making the limewater turbid is the characteristic of carbon dioxide. This experiment proves that large amount of carbon dioxide present in bottle a is released by the seeds.

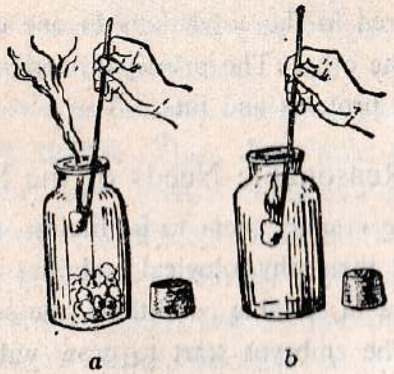

Fig. 16 Experiment showing embryos absorbing oxygen

The above two experiments indicate that during their life processes, the seeds are in a state of continuous respiration, absorbing oxygen and releasing carbon dioxide. The respira-

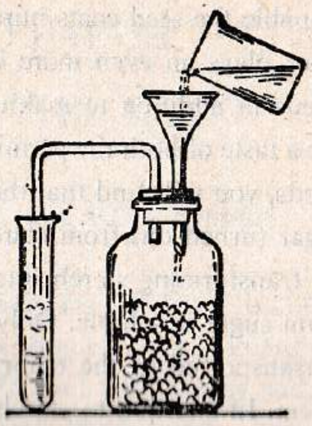

Fig. 17 Experiment showing embryos give out carbon dioxide

tory activity is especially high during germination. Since air containing oxygen meets the need of seed respiration, it is an important requirement for seed germination. No air, no seed respiration, and the life of seeds will be in danger. In fact, not only the seed but also the entire plant body needs to respire throughout its life.

Why is water needed by seed germination? Let's start from a short story. Once upon a time there was a big ship sailing on the Atlantic Ocean. One day, she suddenly sank without any signals recognized. People were much surprised at this because there was neither fire inducing explosion, nor any rock strike. It was at last found out by repeated investigations that the seeds of soybean which full loaded on the ship were soaked and swollen so as to break the bottom of the ship. Of course,

this was not the "purpose" of the seeds. They just took voluminous water to enable the seed coats bursting and the radicles growing out. Water plays an even more important role in the germination of seeds in addition to making seed coat soft and bursting. Just have a taste of both the germinating and the ungerminated barley seeds, you will find that the former tastes sweet. This is due to sugar turned out from starch in the seed. What is the meaning of transforming starch into sugar? Starch is insoluble in water but sugar is soluble. Only substances dissolved in water can be transported to the embryos and be absorbed and utilized by them. In addition to starch, proteins and fats in the seed must be changed into water soluble substances to exert their functions. If the seed is short of water during their germination, how can the nutrients be transported to the embryos?

Seed germination also needs a favourable temperature. Why is it so? As mentioned above, the embryo can only absorb and utilize substances like starch, fats and proteins when they have been transformed into water-soluble substances. It's necessary for the nutrients to be transformed effectively by the help of some special proteins called enzymes. The activity of emzyme is thermally controlled. Only at favourable temperature will enzymes be activated. That is to say, if no suitable temperature is provided with, the transformation of starch, fats and proteins can't go on. If the embryo has no supply of nutrients, the seed fails to germinate. It is, therefore, highly reasonable that air, water and a favourable temperature are the needs for seed to germinate.

CHAPTER IV

THE ROOT

1 Big Root System

The roots of plants are luxuriant but they are never so attractive as the green shoots. It is primarily because most of them are located in the wet and gloomy soil. Plants in nature predominantly have their "underground troops" made of numerous individual roots, which are called the root system.

The root system of cotton is much like the free branches hanging upside down. In the system there is a central thick root which developed from the radicle and is termed taproot, as an old soldier in the troops. The small roots with various length and thickness all around the taproot are descendants of the old soldier and are called lateral roots. Root system like this, in which there is a sharp difference between the taproot and lateral roots, is spoken of taproot system (Fig. 18).

The root system of wheat, originally also had its "old soldier" developed from the radicle. Unfortunately, the "old soldier" was very weak and stopped growing soon after its appearance. Thanks to the numerous roots which grow out from the base of the stem, the troop is thus expanded. Roots developed from stems or leaves are usually called adventitious roots due to their uncertain origin. If there isn't clear difference

Fig. 18 Taproot system of cotton

between the taproot and the lateral roots as in the case of wheat, the root system resembling the beard of an old man is named fibrous root system (Fig. 19). In plants there is no more kinds of root systems except the above-mentioned two.

Fig. 19 Fibrous root system of wheat

The root system is very big. For example, a one-year apple seedling has as many as 38,000 lateral roots, a maize seedling with eight leaves has its root system consisting of 10,000 roots. It was reported that a full-grown winter rye had 14,000,000 roots at its heading stage. If we connect them end to end, they may extend over six kilometers long. Not only has a plant many roots but its root system may grow downward to a great depth, e.g. the root system of wheat may reach a depth of about two meters under the ground, for sugar beet, the figure is about three meters and for alfalfa (Medicago falcata L.) about five meters (Fig. 20). The root system of a desert plant Alhagi pseudathagi may penetrate the soil to more than twenty meters. The horizontal extension of the root system is considerable too. Say, the diameter of root system of maize may be three meters and that of sunflower may be five meters (Fig. 21). An apple tree of cultivar "winter banana", has its root system extending as broad as twenty-seven meters in diameter, more than 2—3 times the width of the crown.

It seems hard to believe such data, but it is not surprising at all when you know the real. It is the big root system that enables a plant to give rise to stems, leaves, flowers and fruits.

2 Exquisite Structure

The root tip is the most active portion of the plant root. It has an extremely exquisite structure.

Let's make a longitudinal section through a root tip (Fig. 22) and examine it under the microscope. Four portions can be distinguished from base upwards: the root cap, growing

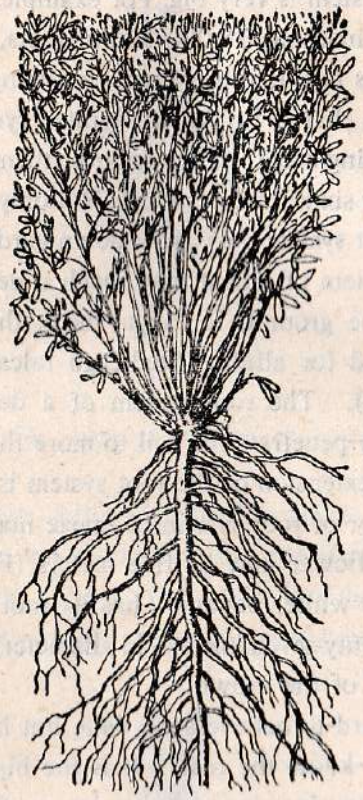

Fig. 20 The root system of alfalfa

point (meristematic zone), region of elongation and the root hair zone.

The growing point is the origin of all cells in root. The cells with the characteristics of small size, dense protoplasm, large nuclei and a great ability to divide here are closely arrang-

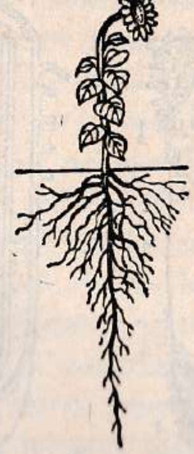

Fig. 21 Distribution of sunflower roots

ed. Once the growing point of root tip is damaged, in other words, the "origin" of cells is destroyed, the root will stop growing soon.

So, the growing point deserves to be cherished. If it were exposed, it would rub against the soil particles when the root elongates in depth. How could these delicate cells bear? It happens that in front of the growing point there is a conical "safety helmet", the root cap. It is composed of many parenchymatous cells and closely protects the growing point while the root penetrates into the deep soil. In the meantime, the root cap itself is usually covered with cuts and bruises, and some cells even die and fall off. Despite of this, the root cap will produce new cells as replenishment. Therefore, it can always maintain its normal shape and thickness.

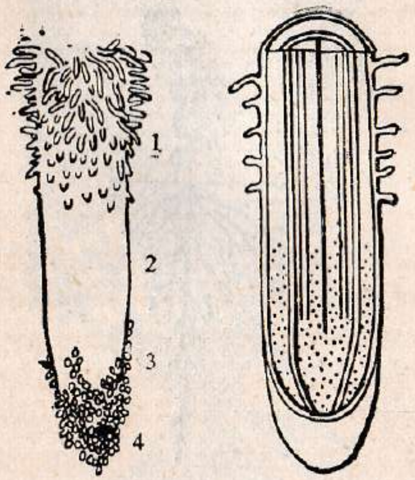

Fig. 22 Longitudinal section through a root tip
1-root hair zone; 2-region of elongation; 3-meristematic zone; 4-root cap

Above the growing point there is a region of about 2— 5 mm long called region of elongation. The cells from the growing point upward to the region of elongation increase their length rapidly. It was measured that when the initial cells in the growing point develop into cells in the region of elongation after 6 hours, their lengths increase nearly 10 times the length before. Obviously, the continuous going forward of the root tip is closely related to "the pushing force" generated by the rapid elongation of cells in the elongation region.

Above the region of elongation, a portion covered with root hairs is known as the root hair zone (Fig. 23). The root hair is an outgrowth of an epidermal cell. Generally it is

0.05 — 2.5 mm long and 5 — 17μ in diameter. Root hair are very short-lived and most of them subsist for no longer than 2 — 3 weeks. Old hairs gradually die and new ones appear with the root tip continuously going forth. How many root hairs are there on an individual root? There was a record that there were over 230 root hairs per mm^2 in the root hair zone of pea (Pisum sativum L.), and over 300 root hairs for apple, over 420 root hairs for maize. Taking an average of 14,000,000 roots for a winter rye plant, the total hair numbers of the entire root system is 15,000,000,000. If we link the roots and the root hairs together, a length of more than 1,100 kilometers will be reached. The root hair, like the "mouth" of a plant, is in charge of uptake of water and inorganic salts. Possessing such a large sum of root hairs, the plant is well-nourished.

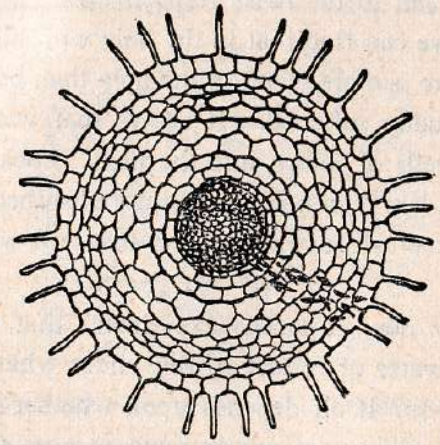

Fig. 23 A transverse section of root hair zone

The root hair zone and the region above it are the mature part of the root. The cells there differentiate into transporting conduits — vessels. It is through these vessels that the water and inorganic salts absorbed by root hairs are transported to the stems and leaves.

3 An Expert With Multi-Capabilities

Roots are the loyal soldiers of plants. They work hard with their multi-capabilities.

Absorption is the principal function and also a special skill of the root. How does the root play a role in it? Let's take water uptake by root as an example to describe this.

We must do an experiment first to explain. Two radishes (Raphanus sativus L.) are required for it. Make a hole on each radish and add some salt water of high concentration and some water without salt to the holes respectively. After a lapse of several hours we can find that in the hole with high concentration of salt there is more water in the hole than before, and the radish is gradually softened. It shows that water has come out from the cells of radish into the hole. Look at the other hole. Water is less than before and the radish becomes harder. It shows that the cells of radish have absorbed water from the hole.

We know now from the experiment that the cells can either absorb water or release it. But under what circumstances do they do so? It all depends upon whether the salt solution out of the cell is more concentrated or more diluted than in the cell sap. If the former is more concentrated than the latter,

water in the cell sap will come out passing the cytoplasm and cell wall. The cell is then softened. And if opposite is the case, water enters the vacuole. The cell thus become harder. That is just the reason why water is absorbed by cells.

The same is true for the mechanism of water uptake by the root hair. Root hairs living in soil attach themselves firmly to the soil particles (Fig. 24). Since there is water between the particles, and moreover, there are inorganic salts dissolved in the water, consequently, water becomes the soil solution. Normally, the salt concentration in cell sap of root hairs is always higher than that in soil. For this reason, the water in soil permeates the vacuoles of root hair cells through their cell walls and cytoplasm. After that it actively passes the cell layers beneath the epidermis, permeates inward progressively by the same mechanism by which cells absorb water, and moves to the vessels at last. From there water flows to the stem.

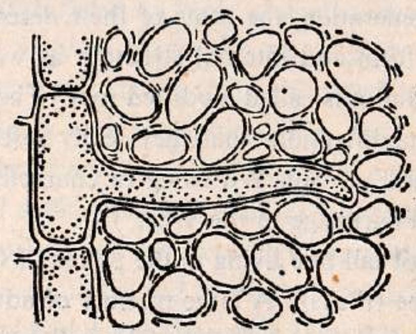

Fig. 24 Growth of root hair attaching to the soil particles

If we consider absorption as the speciality of the root, it has other capabilities, such as anchoring the plant and synthe-

sizing organic compounds.

Perhaps, it is new to you that the root has an ability of synthesis. It appears to be a matter never heard of before. There is nothing strange about this, because the discovery of synthesizing ability of root came forth not very long ago. We will introduce an experiment to you to prove it. It is well-known that there is a great quantity of nicotin (an organic compound) in tobacco leaves. But when the tobacco is grafted onto the tomato, there isn't any nicotin in its leaves. If, however, the grafting partners, i.e. the stock and scion, are exchanged, there is nicotin in tomato leaves. It is explained that nicotin is synthesized only in roots, and that the nicotin in tobacco leaves comes from roots.

4 "Seventy-two Changes" of the Root

As some plant species live in special environments from generation to generation, the roots of their descendants change remarkably in form and internal structure as well as function. So, the changed root is called modified root. There are so many kinds of root modifications that they really resemble the "seventy-two changes" of Sun Wu Kong (a character in a Chinese classic novel "Pilgrimage to the West").

A species of tall tree living in the places of Guangdong etc. is named fig-tree (Ficus). A large number of adventitious roots grow from its trunk and branches. They all extend downward and some of them even penetrate the soil. These are called aerial roots (Fig. 25). They can't absorb nutrients, but can absorb water in the moist air and can respire as well. After the

aerial roots penetrated the soil, they can support the crown. Such a crown is so extensive that "a single tree forming a forest" is a good saying for this.

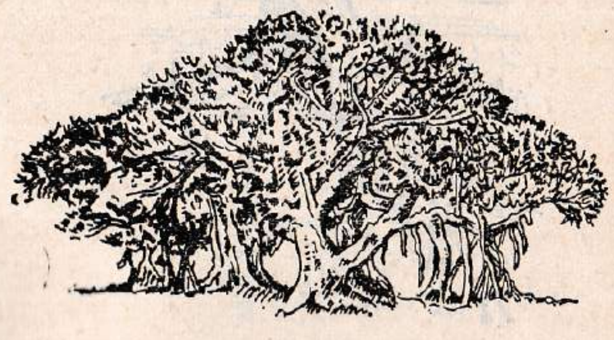

Fig. 25 Aerial roots of a fig-tree

In Hainan Island of our country there is a tree species named Sonneratia caseolaris (L.) Engl. growing on the seabeach with heavy sludge. Since its roots in sludge absorb insufficient air, numerous bamboo shoot-like roots grow out from the ground near the trunk. These roots are called respiratory roots as they help plants with respiration (Fig. 26).

The lodging of maize is not of common occurrence, though its fine and tall stalk often sways in strong wind. Why? There are several whorls of adventitious roots growing on the lower nodes. They penetrate the soil to support the stalk. So the name of supporting roots got into the usage (Fig. 27).

Clumps of adventitious roots grow out from near the node of Chinese ivy. These roots, when young, secret a gummy substance by which they can stick to the wall. When the gummy

Fig. 26 Respiratory roots of Sinneralia caseolaris (L.) Engl.

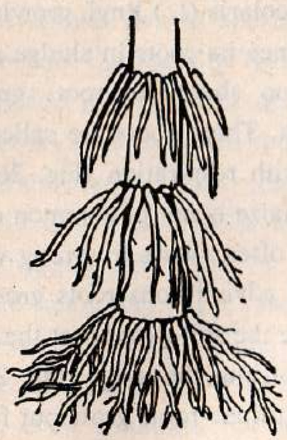

Fig. 27 Supporting roots of maize

substance dries up, the root fixes on the wall tightly. It is by this ability that Chinese ivy can climb the wall. Therefore, the root as such one is called the climbing root (Fig. 28).

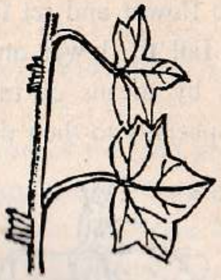

Fig. 28 Climbing root of Chinese ivy

Dodder (Cuscuta chinensis) is a parasitic plant. So long as its seedling touches other plants, especially soybean, it will winds round, and then its underground part dies, and the plant thus starts its parasitic life. Many fine and small adventitious roots will come out from the stem of dodder, and extend themselves into the stems and leaves of soybean to "suck" the nutrients made by the host. The adventitious root of dodder is said to be a parasitic root due to its role of absorption in its parasitic life.

The taproots of carrot (Daucus carota) and radish are swollen and conical or ball-shaped. The adventitious root of sweet potato expands to be tuber-like. Such modified roots are called storage roots, because a large amount of nutrients

are stored in them (Fig. 29). The principal function of storage root is no longer for anchorage or absorption, but is food storage instead. The nutrients stored in roots are essential for plant reproduction. At the expense of these nutrients, both carrot and radish are able to flower and set fruits. Sweet potatoes in the temperate region fail to flower and fruit. They can only reproduce themselves by means of tubers and the nutrients stored in them serve specially to their decendants.

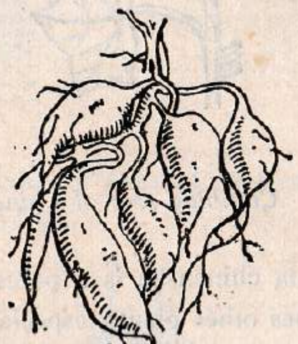

Fig. 29 Storage root

CHAPTER V

LEAVES OF PLANTS

1 An Infinite Variety of Leaf Forms

Spring comes and makes the land green. There are a great variety of leaves in the green sea of nature. The leaf is a noticeable organ in the plant body. The green leaf is a green factory. Moreover, it is a reliable basis for recognizing plants.

The leaf of sunflower looks like a round fan (Fig. 30). The upper flat section is called leaf blade, and the lower slender stalk is called petiole. Like sunflower, leaves of most plants have both leaf blades and petioles.

Leaf blade is the principal part of the leaf, it varies widely in size and form from plant to plant. There is a "Brasilian native" named Royal platter (Victoria regia Lindl.) in the pond of Beijing Botanical Garden's greenhouse. Its round leaf blade reaches 2m in diameter and has an area more than $3m^2$ which is rarely seen in the world (Fig. 31). Some cypresses, Chinese arbovitae (Platycladus orientalis (L.) Franco) and Sabina chinensis cv. Kaizuca are often planted in parks. The leaf blade of them is scale-like of no more than several milimeters. Apparently, it is too tiny to be compared with that of Royal platter. The leaf blades of plants have a great variety of forms (Fig. 32). For convenience, people often name leaves according to

the form of leaf blade. For instance, the leaf blade of wheat resembling a ribbon is called ribbon leaf. The outline of apple leaf is egg-shaped and is therefore called ovate leaf. The cordate leaf is referred to the leaf of such plant as sweet potato which takes the form of an inverted heart. The palmate leaf is applied to the leaf of castor bean (Ricinus communis) which is palm-like. The leaf blade of peach is narrow and long with pointed end, hence named lanceolate leaf.

Fig. 30 Leaves of sunflower

Carefully observing the different forms of leaves, you may see numerous tubes or vessels running through them (Fig. 33). These are called the veins. Veins are also a criterion for distinguishing plants. For example, the leaf venation of monocots such as wheat, corn, rice and bamboo is of paralled arrangement and is called the paralled vein. On the contrary, the dicots such

Fig. 31 Leaf blade of Royal platter

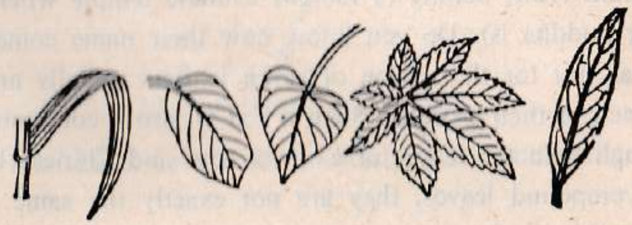

Fig. 32 Some common forms of leaves

as apple, cotton, mulberry and poplar have netted veins. Much like the blood-vessels of human being, the leaf veins restlessly transport water and nutrients for leaf cells.

Chinese rose (Rose chinensis Jacq.) is so lovely a plant with its beautiful flowers. Make a careful observation on its leaves, if you plant it in your home, then you can see something special: there is a number of leaflets growing on a single petiole. We name this kind of leaf as compound leaf. There grow two Chinese buckeyes or seven-leaved trees (Aesculus chinensis Bunge) of hundreds years old in Wo Fo Shi at Western

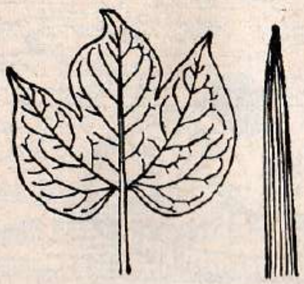

Fig. 33 Veins

Fragrant Hills, Beijing (a famous Chinese temple where a big lying Buddha is). Do you know how their name come from? It was just for the reason of seven leaflets radially arranging on each of their petioles. Such a leaf is also a compound leaf. Though both the leaves of Chinese rose and Chinese buckeye are compound leaves, they are not exactly the same. In the former, the leaflets arrange to be feather-shaped, so the leaf is said to be pinnate compound leaf. In the latter the arrangement of leaflets is like a palm, so the leaf is called palmate compound leaf. Again, it can be further divided into odd-pinnate (Fig. 34) and even-pinnate compound leaf depending on the number of leaflets.

Leaves in nature not only vary widely with different plant species, but also differ sharply in form even on a single plant. The example is arrowhead (Sagittaria sagittifolia var. sinensis) growing in ponds. The leaves may be submerged, floating and aerial with regard to the water, they are respectively ribbon-like, elliptical and arrow-shaped. Three leaf forms occur simultaneously in one plant. Isn't it an interestingly infinite variety of forms?

Fig. 34 Compound leaf

2 The Discovery of Photosynthesis

Photosynthesis is a life process going on in the green plant in the presence of light, through this process organic nutrients are synthesized and oxygen is released. But how was photosynthesis discovered? It took a long time to discover this process.

As early as more than two thousand years ago, an ancient Greek scientist Aristotle believed that having no digestive organ as compared with the animal, the plant body is made of "soil solution". This idea lasted for a good many years.

In 1648, a Dutchman by the name of Jan van Helmont performed an interesting experiment. He planted a young wil-

low tree weighing 2.25 kg. in a pail of weighted soil (Fig. 35) and watered it every day. Five years later the young willow grew to a weight of 76 kg. but the soil had only lost 0.1 kg. In fact, the experiment proved for the first time that a significant amount of water was needed in photosynthesis.

In 1773, Joseph Priestley, an English man also performed a meaningful experiment (Fig. 36). He put a mint plant and a mouse together in a sealed bell jar, the mouse gamboled around and brimmed with vigour. After he took out the mint for some time, he soon found the mouse had died. In fact, this experiment showed for the first time that photosynthesis is a carbon dioxide-requiring process as well as an oxygen-releasing one.

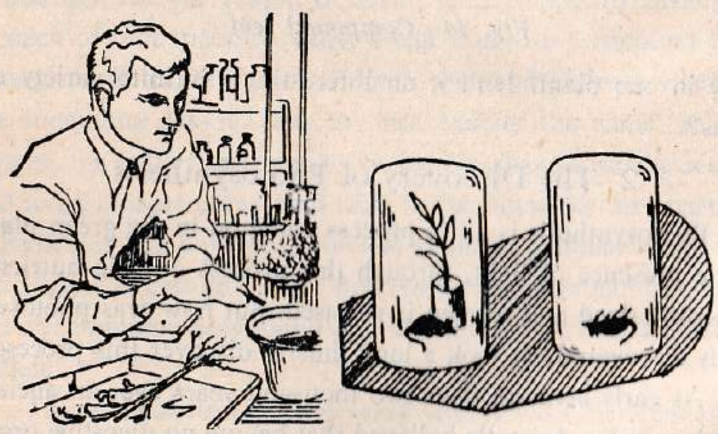

Fig. 35 Helmont's experiment Fig. 36 Priestley's experiment

Many scientists worked hard on this process after Priestley's experiment. They continued to prove that photosynthesis

needs light, produces organic nutrients and that the manufacture of organic nutrients occurs only in the green parts of a plant. It was not until seventeen ninety-six that Ingen-Housz, a Dutch man, based on these facts, came to the conclusion of what photosynthesis was. He found out that light is provided as the motive power for photosynthesis in green leaves, and that both carbon dioxide and water are its raw materials, and organic nutrients and oxygen are its product and by-product respectively.

3 Green Factory

Green leaves are the main organs that carry on photosynthesis. Since there are motive power, raw materials, product and by-product in the process, the green leaf is therefore, well resembled the "green factory" (Fig. 37). What is the structure of leaf, the green factory? Now let's have a look at the transverse section of it under microscope.

Both at the upper surface and lower surface of the leaf there is a layer of cells arranging closely into an epidermis. Much like the wall of a factory, the epidermis acts as a protecting apparatus to prevent the internal substances from going out easily and the external substances from invading in. Of course, the two layers of walls are out of the ordinary. They are as transparent as glass to enable light passing through. There are many stomata distributed on the leaf epidermis, especially on the lower one. It was counted that generally there were 100 — 300 stomata per square milimeter on the lower epidermis of the leaf. The stomata are comparable to the windows on the

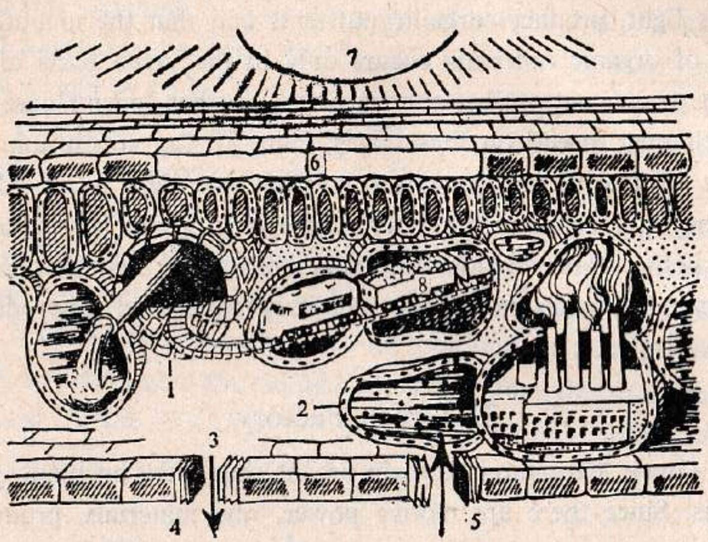

Fig. 37 Green factory

1-vein; 2-water; 3-oxygen; 4-stoma; 5-carbon dioxide; 6-leaf epidermis; 7-solar energy; 8-sugar

wall, they can be opened or closed. They are the passages for gas exchange with the environment. It is through the stomata that carbon dioxide, the raw material of photosynthesis, and oxygen, the by-product, pass in and out respectively. Between the upper and lower epidermis there are many round and column shaped cells called mesophyll cells. If you examine them closely, you may find many green particles within. These are chloroplasts containing chlorophyll, whose function is principally manufacturing organic nutrients. So, mesophyll cells may be considered as workshops. Among the mesophyll cells there lie the veins. They are the transport lines in plant leaves,

which are composed of two different tracts. One is the vessel system in charge of conducting the water and inorganic salts absorbed by roots to the "workshop". The other is the sieve tube system through which the organic nutrients synthesized are carried to other organs such as stems and roots.

Having observed the transverse section of leaf, you will be surprised at its exquisite structure with very nice equipment. It is really like a small factory.

4 Beautiful Red Autumnal Leaf

"How lovely is the red autumnal leaf of Western Hills!
The heavier the frost is, the more gorgeous the leaf colour will be.
So is the revolution. Real heroes only come from serious struggles".

This is a glorious poem "Praise on the red autumnal leaves of Western Hills" made by our late Vice Premier Chen Yi. Inspiring the revolutionary spirit of our people, the poem makes the red autumnal leaves of Western Hills even more splendid and lovely. Beijing is also famous for its "red autumnal leaves of the Western Hills". And so you are warmly welcomed to go sightseeing on the beautiful Western Fragrant Hills around the Frost's Descent time, if you please. You will see the whole Hills covered with red, which makes you feel highly relaxed and happy.

The red autumn leaves of Beijing Western Hills are mainly the leaves of common smoketree (Cotinus coggyria Scop) (Fig. 38) which possesses a height of 3—4 meters. Its leaf, like

a small cattail leaf fan, is very attractive. It is a well-known tree with leaves that turn red in autumn. In fact, in parks there are many plants which bear leaves turning red in autumn. Among the famous ones are maple (Acer.), Chinese tallowtree (Sapium sebiferum (L.) Roxb.) (Fig. 39) and beautiful swedgum (Liquidambar formosana Hance). Aren't leaves green? Why the leaves of those plants can turn red in autumn?

Fig. 38 Common smoketree *Fig. 39 Chinese tallowtree*

Leaves of green plants contain large amount of chlorophyll as mentioned above. In addition to chrolophyll, there are other pigments such as xanthophyll and carotene in leaves. As the leaf of the green plant lives normally during the growing season, the old chlorophyll is decomposed while the new one is produced all the time, so the chlorophyll in the leaf masks the other pigments and keeps the leaf fresh green in colour. But when autumn comes, the formation of new chlorophyll stops as the weather becomes cold. As the contents of chlorophyll decrease day after day, other pigments in the leaf begin to show

up. The leaf containing relatively more xanthophyll and carotene appears entirely golden colour by this time. In leaves of the "red leaf-tree" appears another pigment termed anthocyanidin. Ordinarily it is a colourless pigment, but it possesses a characteristic of being red when it meets acids, and turns blue when it meets alkalis. If you don't believe it, just make an experiment as follows: put the red leaf into a beaker with water and boil it, then the water will turn red soon. If you add some dilute hydrochloric acid to it, the water will be even more red. Again, if you add a few drops of alkaline water, the red water will change into blue. Owing to its acidic nature, the leaf of the "red leaf-tree" appears red in autumn.

The red autumnal leaf is beautiful. People love it as much as love Yulan magnolia (Magnolia denudata Desr.) in spring, hindo lotus (Nelumbo nucifera Gaertn) in summer. As soon as the fine season of autumn comes, millions upon millions of visitors gather in the red autumnal woods of the Western Fragrant Hills.

5 Carnivorous Plants

People often call the man who only has plants as food a vegetarian, while the man who eats also animals as food a meatarian. Are there any meatarians in the plant kingdom? Yes, not only there are, but also there are many in number. The carnivorous plants are mainly insectivorous plants. There are more than four hundred and fifty species common in the world and over thirty species occurring in our country.

Talking about the insectivorous plant, perhaps you have

an idea that animals always eat plants. So the reason why certain plants eat animals may be just for revenge. However, as a matter of fact, it is not the case at all. Generally, the insectivorous plants grow in the soil deficient in nitrogen as well as other inorganic salts and have poorly-developed root systems. Adapted to this environment from generation to generation, the leaves of such plants have formed finally various sticky and bizzare traps to obtain nitrogen supply for their lives. It is by these peculiar apparatus that the plants catch insects and other small animals.

Venusflytrap (Dionaea sp.) is a rare insectivorous plant cultivated in many botanical gardens in the world. Its leaf highly resembles an open shell. There grow a few sensitive bristles at the inner side of blades (Fig. 40). As soon as an insect comes to touch the bristle the shell-shaped leaf closes up and it opens again only when the insect has been eaten up, awaiting for new food to come.

Common nepenthes is an insectivorous plant in Hainan Island of China. There is a "small bottle" hanging at the tip of each leaf, the bottle is provided with a half opened lid to keep from the rain. The plant is named common nepenthes (a herb which looks like a cage in Chinese meaning) (Fig. 41) because the small bottle on its leaf resembles very much the cage used by the Southerner for pig-carrying. The small bottle is of a wide range of beautiful colours. It releases fragrant odour and secrets sweet juice from the lid or the inner wall. The greedy insects duped often visit it. While drinking the juice, the insect in the mouth of the bottle slips easily into it. The insect is

Fig. 40 Venusflytrap

then stuck on by the mucilage on the bottom and can never creep out again, it is then eaten by the common nepenthes.

Bladderwort is a common waterweed in ponds and also a famous insectivorous plant. There are many small sacks on its submerged leaves. These sacks are insect-catching sacs (Fig. 42). Their structure is very interesting. On the mouth of the

Fig. 41 Common nepenthes (Nepenthes mirabilis)

sac there is a small lid that can open only inward and bears hairs on it. When the small insect in the water moves over and touches the hair, the lid opens inward to let it in. In this way the insect can't go out any more.

Having had known the above-mentioned insectivorous plants, you may wonder why plants without any digestive organs can eat insects. Now you will see the reality is that there is a structure termed digestive gland in the insect-catching apparatus of whichever insectivorous plant. These glands can secret viscous fluids which contain a large amount of proteinase and are much like the digestive juice secreted by the digestive organs of animals. The proteinase can digest animal proteins. It is by these digested proteins that the insectivorous plant can thus support its life.

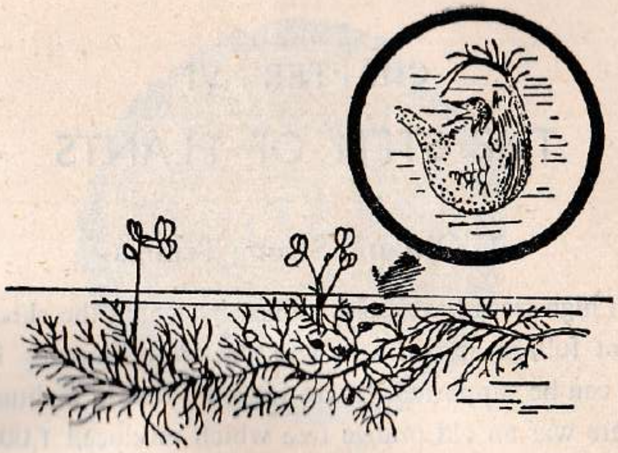

Fig. 42 Insect-catching sacs of bladderwort

CHAPTER VI

THE STEM OF PLANTS

1 Old and Strong Trunks

All high trees have bold trunks, by which the shoots with luxuriant foliage spread out, and the fruits hanging in close clusters can be supported. It was reported that in Sichuan Province there was an old orange tree which produced 1,000 kg of fruits in 1979, showing that the trunk could withstand the strong force. Why do the trunks possess such great strength? Let us explain this with "chopping block".

The plane of the chopping block, in fact, is the transverse section of a woody plant stem (Fig. 43). Its outer layer is a circle of softer texture called bark, which is easily peeled off. If it is stripped off, you may find a lot of filaments called phloem fibres, which are slender cells with heavily thickened walls and high elasticity not easily broken. The inner part of the bark, where the phloem fibres are, is called phloem. After the bark is got rid of, you have the wood or xylem. There are a great deal of wood fibres in the xylem. These fibres are also elongated cells with thickened walls, similar to those in phloem, the only difference is that they are very hard without any elasticity and not easily bent. Therefore, the wood can be used to build houses, make boats and furnitures, etc. The xylem part of perennial woody plants increases its width every year. If

Fig. 43 Transverse section of a woody plant stem

you do not believe it, you may watch a chopping block. On its transverse section there are many rings called annual rings or growth rings. The seasonal differences in weather and rainfall in a year make the xylem closely or loosely textured, a conspicuous growth ring is thus formed in the xylem of the trunk. By counting the numbers of growth rings on your chopping block, you may know the age of your chopping block.

2 Varied Vines

In nature, the stems of some plants are thin and long, for example, those of devilrattan (Daemonorops margaritae) which can be used to weave rattan chairs and baskets, reach a length of 300 meters. They are too soft to stand upright. These plants are usually called vines or trailing plants. Their stems bear the supporting function as those of woody plants. How

do they themselves exert this function?

The delicate stems of morning glory (Ipomoea), Chinese yam (Dioscorea batatas), kidney bean (Phaseolus vulgaris) cannot stand upright, but they are able to twist other things for going up and extending their leaves into air just as those of upright woody and herbaceous plants. These stems are called twining stem (Fig. 44).

The stems of grape (Vitis) and cucumber (Cucumis sativa) are also delicate and cannot stand upright. They are not able to twine other things to climb, but they have tendrils, which can wind other things to enable their stems growing upward. This type of stems are named climbing stems (Fig. 45).

Have you ever seen any boston ivy (Pathenocissus tricuapidata)? Its stem is also climbing. There are tendrils on the stem, the tendrils are branched and at the end of each branch tendril there is a structure like sucking disc, by which the stems attach the wall to climb.

The stems of sweetpotato (Ipomoea batatas) and strawberry (Fragoria) neither grow upright, nor attach other things to develop in air. They are only able to creep on the ground to make the leaves spreading out in the sun. This kind of stem is designated as stolon (Fig. 46).

3 Transport Lines Extending in All Directions

Like the body of a man, the plant stem has a more important role in transportation besides supporting. The stem has the function of transporting water and inorganic salts absorbed by

Fig. 44 Twining stem of morning glory

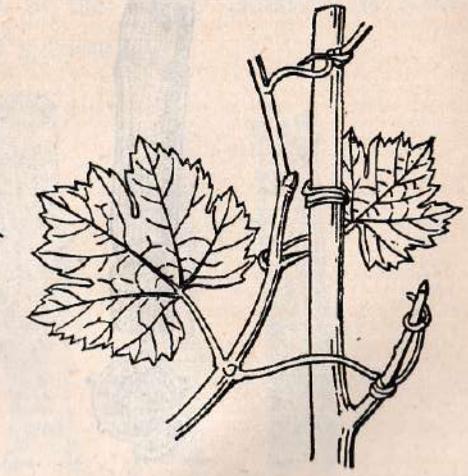

Fig. 45 Climbing stem of grape

Fig. 46 Stolon of sweetpotato

the roots upward, and transporting back organic nutrients made by its leaves to the roots downward. Why does the stem possess this function? It is because there are transport lines extending in all directions. The lines include two kinds of conduits — sieve tube system and vessel system which have been described in the chapter on the leaf.

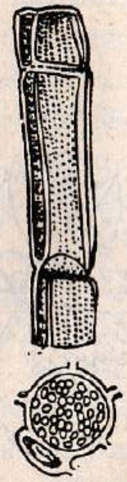

Fig. 47 Sieve tube

The sieve tube consists of many cells which are connected with each other (Fig. 47). There is a sieve plate where the cells are joined together. The small pores on the plate make the cells to be linked up. The sieve tube system seems to be a big blood vessel of plants through which the organic nutrients made by leaves are transported. There are a lot of sieve tubes in stem, so the efficiency of transporting nutrients is high. The nutrients manifactured in leaves can be transported to roots within one hour. Where are actually the sieve tubes? Well, they exist in the phloem of bark together with phloem fibres. The children in countrysides are all familiar with the small board hanging on the small trees on the road side. It says "Do not tie domestic animals on the trees". That is because people are afraid of the bark to be gnawed off by the

animals. If the bark of the tree is damaged, its roots will die because of lack of nutrients.

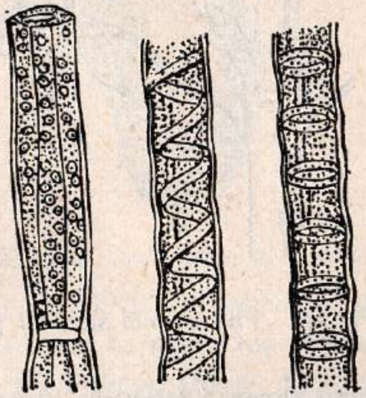

Fig. 48 Vessels

The vessel system also includes cells joined with each other by themselves (Fig. 48), but there is nothing existing between two cells. It resembles a hollow bamboo tube. The vessel system also seems to be another blood vessel, through which water and inorganic salts absorbed by roots can be transported. The efficiency of water and inorganic salt transportation is also high because of many vessels in stems. It only takes a few hours to carry water from roots to the top of a tree which is 100 meters tall. Where are the vessels in stem? They are located in xylem together with wood fibres.

4 The Forms Much Varied but Essentially the Same

Generally, stems of plants are cylindrical with a definite length (Fig. 49), but in some plants, the morphology and func-

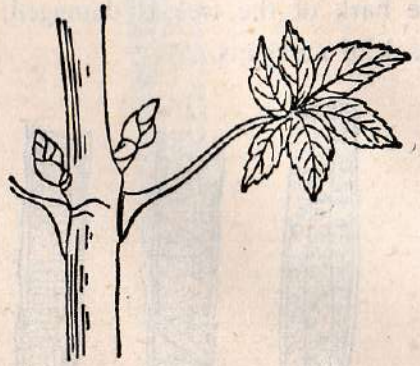

Fig. 49 The normal stem of plants

tion of stems have changed markedly because they have lived in and been adapted to different complicated environments for a long time. These stems which are specialized in morphology and function are called modified stem. In spite of the wide range of modifications among metamorphic stems, they are essentially the same. That is to say, you can always find nodes, internodes and buds at definite positions.

Potato is a common vegetable. It looks like sweetpotato. However, it is different in essential aspect from the latter, because the former is a metamorphic stem, rather than a root. If you examine it carefully, you may find small holes on its surface. There is a bud in each hole called "eye". The nearer to the tip of potato, the more are the eyes. At the bottom of each eye there is a thin membrane called scale leaf. Possessing leaves and buds, potato is, in fact, a stem. This kind of stem is called stem tuber (Fig. 50).

Fig. 50 The stem tuber of potato

Onion (Allium) is a kind of common vegetable. Is it a root or stem? If you want to reveal the mystery, you should observe it carefully. The onion is like lily bulb. Its outer layers consist of a number of thick, fleshy scales which are leaves. If the scale leaves are stripped off, there is a disc-like structure (Fig. 51), from which new leaves grow out. It is therefore a

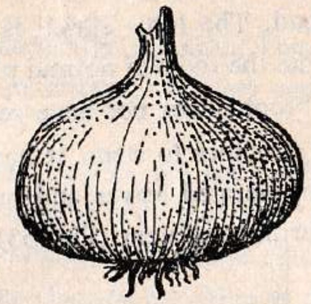

Fig. 51 The bulb of onion

stem. This kind of stem is called bulb. Actually, not only can leaves, but also buds, grow from bulb. We usually see the buds growing out from the stem tip and leaf axil of the onion which

have been preserved for some time.

Waterchestnut (Eleocharis tuberose) is also eaten as food, which can be used to make starch. It is also a modified stem called corm because it is ball-shaped (Fig. 52). If we compare waterchestnut with normal stems of plants, although different in their appearances, the waterchestnut corm has also noticeable nodes and internodes. On nodes there are membranous leaves from which axillary buds grow out. In addition, there is a terminal bud on the tip of its stem.

Fig. 52 The corm of waterchestnut

The lotus root (the stem of Nelumbo nucifera) is also a kind of common food. The lotus starch is made from it. It lives in sludge just like the roots of normal plants extending into soil. However, the "root" does not have real root characteristics, it is similar in structure to stem. It has terminal bud, obvious nodes with degenerated leaves and buds. This is a kind of stem called subterraneous stem (Fig. 53).

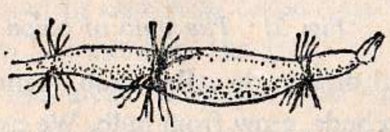

Fig. 53 Lotus root (the subterraneous stem of lotus)

CHAPTER VII

FLOWER AND FRUIT OF THE PLANTS

1 Flowers Blossom in a Riot of Colour

When spring comes and the ground is covered with jade green, the plant kingdom is tinted with flowers in a riot of colour. All the flowers with different colour, such as camellia (red flower), peach (pink flower), golden winter jasmine (yellow flower), and pear (white flower) are dressing up nature with tenderness and loveliness. When you see the flowers in a blaze of colour, perhaps, you may wonder why they have so many colours?

It is easy to answer the question. The main reason is that the cells of petals in different flowers contain pigments with different colours.

In nature, some flowers are red or blue. What kind of pigments do they contain? You may pick off a red flower of morning glory and immerse it in dilute alkaline water, you will notice the red flower changes into blue at once. If you put the blue flower back in dilute hydrogen chloride solution, it becomes red again. Is it the anthocyanidin mentioned previously that is responsible for the red colour in acid solution and blue one in alkaline solution? It is known that petal cells of either

red or blue flower contain the same anthocyanidin. It is the pH value of the cells that makes the difference.

In nature, there are some yellow and redish orange flowers. The pigment in the cells of their petals is yellow carotene. There are many kinds of carotenes, showing colours in different shades. The same is true for the colour of the yellow petals. Then, what kind of pigments is in white flower? It should be said that the typically white flower does not contain any pigments. The white colour visible to you actually is caused by small bubbles present in petals. If you take a white petal off and rub it slightly with your fingers to get rid of the bubbles, the white petal will become transparent. Not only are the colours of plant flowers various, the flower shapes are also different (Fig. 54). For example, flowers of morning glory, broad

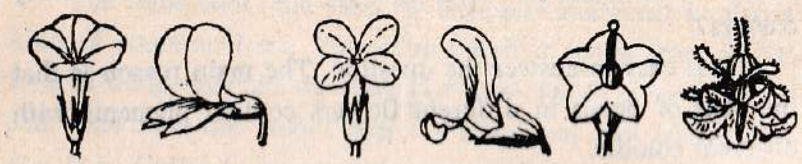

Fig. 54 Flower shapes

bean, Chinese cabbage, mint, egg plant, and pumpkin are very much like, respectively, funnel, butterfly, cross, lip, wheel and small bell. They are called respectively, infundibular, papilionaceous, cruciferous, labiate, wheel-shaped and mitriform flowers. There are thousands upon thousands of flowering plants in the world. Since the flower of each plant species has definite shape,

the flower shape just like the leaf form, is also an important indicator by which the plants can be known.

The flower size also differs in thousands of ways. In summer, we often see waterlily flower in ponds. It should be said that they are large enough, but the biggest flower in the world is many times larger than that of waterlily. There is a plant which lives in parasitic way in the virgin forest at islands of Java and Sumatra in Indonesia. This plant only has one big flower called rafflesia (Rafflesia) (Fig. 55) which spreads on ground without any leaves. This flower consists of five petals with about one meter in diameter and four kg. in weight. It is really the king of flowers! People may think that the smallest flower in the world is date flower. In fact, there are in nature a lot of flowers which are smaller than date flower, such as common fig flower which hides in "carnous ball" (Fig. 56). The flower cannot be seen at all unless dissected out and observed with a magnifier.

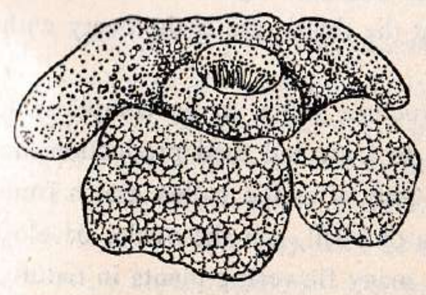

Fig. 55 Rafflesia flower

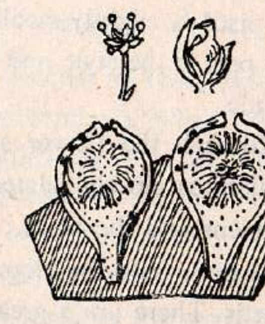

Fig. 56 Fig flower

2 For Whom Do the Flowers Blossom?

For whom do the bright coloured flowers blossom? This question was a mystery long ago. At that time, it was considered that God created flowers for people to enjoy. So they blossom for people. Many years later, a German botanist, Springer found that a flower was a reproductive organ of seed plants. Only after plants flower, can they produce fruits with seeds for reproduction. How do the flowers set fruits with seeds? In order to understand this, it is necessary to start with flower structure. Let us examine a peach flower (Fig. 57). You may see a short stalk at the base of it, which is called pedicel. Above the pedicel there is a cup-like structure termed receptacle holding green sepals, pink petals as well as stamens and pistil. There are many stamens in a peach flower, each of which consists of a slender filament and a swollen anther. The anther contains a large number of pollen grains which can spread out from dehiscent anthers when the flower is blossoming. Peach flower only has one pistil which is very much like a flask. The top of the pistil is slightly swollen into the stigma. In the slender middle part is the style and at the thick base is the ovary with one ovule.

Although the flower structure seems to be complicated, the structures closely related to fruit and seed production are the stamens and the pistil. Only after the pollen grains from stamens drop onto the stigma of pistil, can the ovules develop into seeds. There are a great many flowering plants in nature, their flower structures are not all the same as peach flower.

Fig. 57 The structure of peach flower
1-petal; 2-stamen; 3-pistil; 4-septal; 5-ovary

For examples, cucumber and maize have male and female flowers, the stamens and pistil do not exist simultaneously in one flower. Plants such as hemp (Cannabis), spinach, poplar, willow and mulberry (Morus) have male and female flowers which are not borne on the same plant. Therefore, these plants can be distinguished as male and female ones.

3 Pollination Vehicles

Most of the flowering plants depend on cross pollination to produce their fruits and seeds except pea, wheat, rice and sorghum etc. Which rely on self-pollination (Fig. 58). How are pollen grains from one flower dispersed to the stigma of the other? There are many vehicles for pollination.

In parks, you may see bees, butterflies fluttering among flowers. These insects are the main vehicles for cross pollination (such flowers are called entomorphilous). Why can the

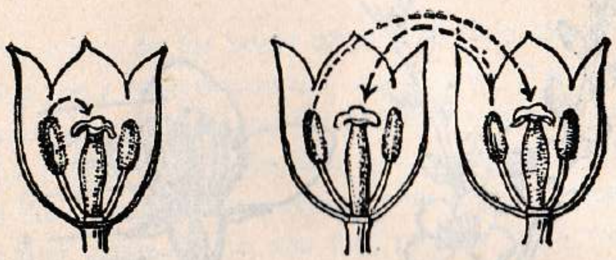

Fig. 58 Self and cross pollinations

flowers give an invitation to insects for a help? That is because they have three precious secrets — beautiful colour, sweet fragrance and luscious honey. In the world of flowers with gorgeous colours, you may find that most of flowers are white, red, yellow and blue if you observed carefully. It was reported that there were 1,193 plant species with white flowers, 951 with yellow, 923 with red and 594 with blue ones among 4,197 plant species. Few are of the other colours. Why? This is because the red flowers attract insects most, yellow and blue flowers can be easily recognized by bees, while most flowers which come into blossom at night are white as they can be seen clearly by mothes even under weak light.

The fragrance of flowers is more attractive than their colours. In an interesting experiment, a great number of butterflies and bees were attracted by coloured paper flowers with a little bit essential oil on them to be sticked on shoots. It was strange that some plants have flowers which release bad smell instead of sweet fragrance, the above mentioned rafflesia, when in full bloom, give out a smell similar to that of decayed fish and shrimps. This smell keeps bees far away, but attracts flies. When flies come to rafflesia for a visit, the plant lets them pollinate itself. Honey, a secretion produced from nectar cells is rich in sugar which is one of the most precious secrets among the three ones. Generally, flowers produce honey at a certain time, most of them produce honey before pollination. Flowers entertain insects with honey, and insects thank them for their hospitality with pollination.

Wind is also a vehicle of cross pollination (the flowers are called anemorphilous flowers), but it does not seem to be worthy for the plants to be pollinated by wind. Statistics showed that only one among 1,440 pollen grains from two flowers which are at a distance of 2.5 kilometers apart, is possibly transported onto the stigma of pistil, most of them are blown away by wind. In order to increase the chance of pollination, the anemorphilous flower brings forth a great deal of pollen grains, for example, maize plant produces 2×10^7—5×10^7 pollen grains. The pollen grains from anemorphilous flower are not only numerous in quantity, but also light in weight, so they can fly far away with wind, for instance, pine pollen grains can migrate out of 50 kilometers with favourable wind. Large amount of light pollen grains are very beneficial for pistils to be pollinated.

Water may also carry pollen grains for some plants, such as spiral wildcelery (Vallisneria apiralis) living in water and taking water as its pollinating vehicle (Fig. 59). This plant is a heterothallic one. Male flowers grow at the base of male

Fig. 59 Spiral wildcelery

plant, female flowers are held up to water surface by the slender stalk of female plant. When the plants are blossoming, the male flowers separate from the plant and float on water surface, drifting with the current. Once they run into female flowers, their pollen grains drop onto the stigmas of pistils. Besides insects, wind and water as pollinating vehicles, birds can also serve as an agent carrying pollen grains. In Latin America there is a kind of bird called Humming bird (Fig. 60), which only has 5—6 cm in body length. It has a slim mouth and tongue with the ability to stretch out and withdraw freely. It often flies among flowers and, particularly, picks up honey and eats small insects on flowers. Therefore, it can help flowers of a number of plants there with pollination. It was said that the red flowers are most loved by humming bird.

4 Bringing up New Generation

Pollination is prerequisite to fruit and seed formation.

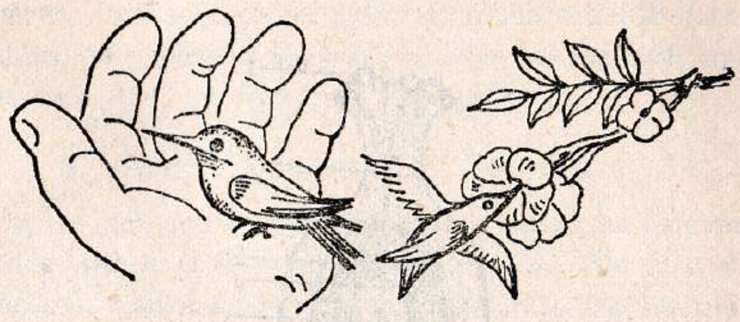

Fig. 60 Humming bird

Well, how are fruit and seed formed? First, pollen grains and stigma should be recognized with each other when the former fall to the latter. At that time, proteins released from pollen wall will interact with proteins on the stigma surface. If both sides are convinced that they belong to the same species, the pollen grain will protrude a cylindrical pollen tube from its wall. The pollen tube grows downward along the style into the ovule of ovary. After it enters the ovule, a pore forms at the tip and two sperms are released, one of which fuses with the egg cell (ovum) in the ovule to form zygote. The zygote divides itself many times and finally develops into the future small seedling — embryo. The other sperm fuses with the two polar nuclei in the ovule and develops into a nutritive tissue special to the seedling known as endosperm. With the growth of the embryo and the endosperm, the ovular wall (integument) surrounding them correspondingly develops into the testa (episperm). At this time, the seed as a new generation of plant is gradually formed (Fig. 61).

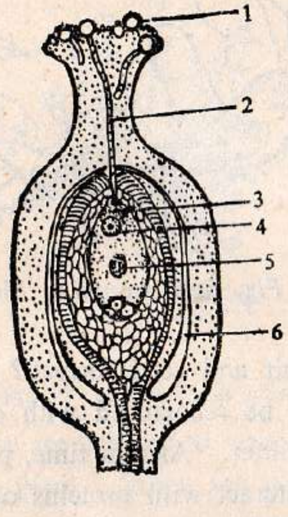

Fig. 61 Fertilization process of flower
1-pollen grain; 2-pollen tube; 3-sperm; 4-egg cell; 5-polar nucleus; 6-integument

In many plants, outside the ovule is the ovary wall which develops into fruit simultaneously with the formation of seed. For example, the shell of peanut and sunflower, the pod of kidney bean, the downy thin peel of peach and apricot, their sweet and sour pulp with the hard shell inside all are parts of a fruit. It is apparent that not all parts of fruit are edible.

Here, probably, you will ask: are there some kinds of seeds lacking endosperm? What has happened then? This is because that the endosperm is absorbed by the seeds after they began to develop. Examples are seeds of kidney bean, cotton,

cucumber. In those cases the nutritive substances are all transferred into the cotyledons which are therefore full and thick, and at the same time, the endosperm disappears.

5 Some Plants Are Also Viviparous

In the rich and colourful biological world, the patterns of giving birth to children are of varied forms. The new individuals of mankind and mammals develop in the mothers' bodies. Consequently, the person once born is a baby, and the cattle once born is a calf. This mode of reproducing progenies is called viviparity in biology. The green flowering plants differ from human beings and mammals. When the plants propagate their progenies, the mature fruits and seeds generally depart from their mothers' bodies. The seed will germinate into a new plant under appropriate conditions. But there is no rule without exception. A few among about 200,000 flowering plants, different from the great majority, are able to reproduce viviparously. For examples, finger citron (Citrus medica var, sarcodactylis) cultivated in South China, mangrove (Rhizophora) at sandy beach of tropical seashore, and Cryptocoryne Ciliate Fisch. ex Schopt in marshland in Southeast Asia are all viviparous plants. The seeds of these plants, after they are mature, do not leave their mothers immediately. They germinate inside the fruits, some of them even absorb nutrients from their mothers through the cotyledons, and gradually develop into seedlings (Fig. 62). The seedlings, when growing to a certain extent, come off from their mothers' bodies, and grow on the ground. The seedlings leaving their mothers'

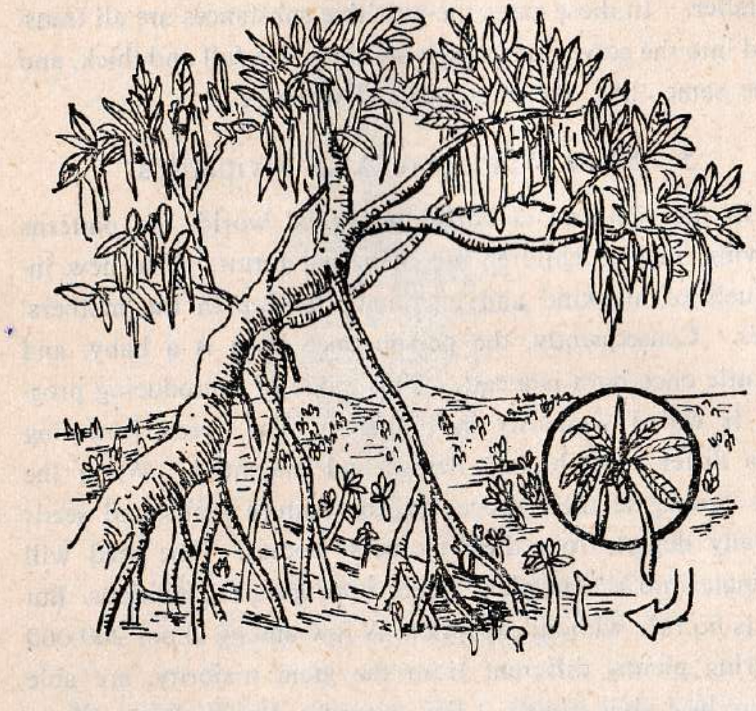

Fig. 62 Mangrove and its viviparous seedling

bodies are much like newly born babies except that they cannot cry "wa wa".

CHAPTER VIII

DISPERSAL OF SEEDS AND FRUITS

1 Dispersal by Wind

Fruits and seeds, after ripen, usually go away from their parent plants to be distributed so as to develop their families in a larger scale. There are a variety of ways to distribute seeds in nature. Among them, the seed dispersal by wind is also common. The thin and brown fruit of dandelion (Fig. 63) very often seen in fields has a beak, at the tip of which there are a lot of downs radially arranged that look like a small para-

Fig. 63 Dandelion fruits

chute. It can be blown far away when a gust of wind comes over. After the fruits fall on ground, they grow up as new dandelion plants if suitable environment is provided.

In spring, on elm (Ulmus) tree there are strings of round things. In fact, they are the fruits with round wings in which the seeds are centrally located (Fig. 64). The ripened fruits may

Fig. 64 Elm fruits

run far away in floating and trundling fashions by wind. The fruits of maple (Acer) look very much like small shoe-shaped silver ingots of ancient China, but they are very light. Like fruits of elm tree, fruits of maple also have membranous wings and are also able to fly in air by wind (Fig. 65).

Do all the fruits distributed by wind have downs and wings? No, they are not exactly the same. For instance, the

Fig. 65 Maple fruits

seeds of orchid etc. do not have any thing special, they can also be dispersed to a very long distance by wind due to their small and light bodies. Do you remember the smallest seeds of goodyera in the world? Each of their seeds is as small as dust only weighing 2×10^{-7} grams. Undoubtedly, these seeds are not easy to germinate, but some will meet suitable environment and grow up as new plants in the end, because they are produced in a tremendously large quantity every time.

2 Animals Do Plant a Favour

Some plant seeds possess special structures which are fitted for animals to carry along. For examples, the seeds of cocklebur (Xanthium), beggarticks (Bidens bipinnata) have hooks and thorns (Fig. 66) by which they not only defend themselves,

but also hang themselves to peoples' clothes and animals' fur to have a long journey. When they are found by people and animals, they must be thrown away in a new place where new plants will grow if it is suitable to them.

The seeds of asiatic plantain (Plantago asiatica) and melons, when eaten by people and animals, may be excreted with feces only if they are not broken. These seeds still have the ability to germinate. Someone found that the germination rate of seeds from robins' (a bird) excrements reached more than 80%. In particular, the seeds of three-coloured amaranth (Amaranthus tricolor) and nettle (Urtica) etc., after soaked by digestive juice of animals' stomach and intestines, possess even higher rate of germination. The ripened peach, apricot, plum with sweetness and fragrance are not only eaten by people, but also tasted by animals. A large number of kernels left are usually thrown away or excreted out again after eaten, so the seeds get a new home of themselves. Darwin, a well-known biologist, anatomized a bird and found that in its stomach there

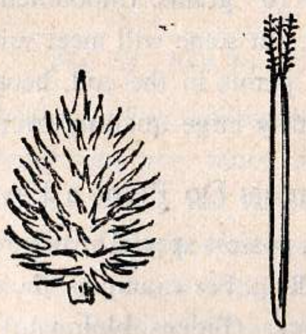

Fig. 66 The fruits of cocklebur and beggarticks

were twelve different kinds of seeds. It is evident that the animals offer great help to seed dispersal.

3 Seeds Driven by Water Current

There are also a lot of plants which depend on water to disperse their seeds. These seeds usually travel everywhere by the chance of irrigation in fields, river flow, and the rising and descending of seatide.

The viviparous seedling of the mangrove as mentioned above, after departing from its mother, can float on the sea for a long time without losing its life. Once it is driven to the seashore, its roots penetrate into the sand immediately for seedling growth. There is a well known forest of coconut palm in Hainan Island of our country. The fruit — coconut (Fig. 67) as big as the head of people (with a seed in the center), is a good navigator. On its surface there is a thin waterproof peel. Inside the peel is a good deal of coir full of air, making the fruit specially light. The coconut at seashore, once ripened, and dropped onto the sea, will floats with current, even cross the vast ocean. When the coconut arrives at a new seashore by waves, it will settle down there.

Waterlily is also a plant which depends on water to disperse its seeds. As each seed carries a bag-like air sac, it can thus float on water. During its traveling, the air in the sac becomes thinner and thinner, and the seed slowly sink to the bottom of ponds or rivers. A new plant will grow in the second year after the testa decays.

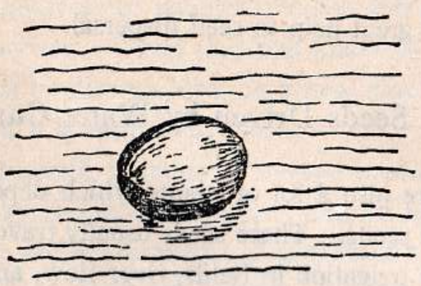

Fig. 67 Coconut

4 Seed Dispersed Through "Self-reliance"

In nature, the seeds of some plants neither rely on wind, nor water to be dispersed. They make efforts through themselves to do so.

All the experienced peasants know that the beans in fields must be harvested in time. If not, the dry pods split suddenly and send forth seeds strongly to all directions. Snapweed (Impatiens) also have the same capability. After ripen, the fruits split suddenly in a spiral way and the seeds can be shooted out more than 2 meters due to the unbalanced force from inside and outside the pod.

Most interesting is squirtingcucumber living in Central Asia (Fig. 68). Its fruits, with bristles on its surface, like a small melon, hang quietly on the shoot. When the seeds are mature, much mucus appear in fruits. Once the fruit separate itself from its stalk, the peel shrinks immediately and exerts a high pressure. In this case, the seeds and mucus altogether

are sprayed out to 5 — 6 meters distance. Have you ever heard of a fruit able to climb? The example is the fruit of a plant called blue cornflower (Centaurea cyams). When the weather is bright and dry, the hard hairs coating the fruit stretch out. After the hairs are wet by rain or dew, they contract again. In this way, the fruits can continuously climb forward to look for a new home for their seeds.

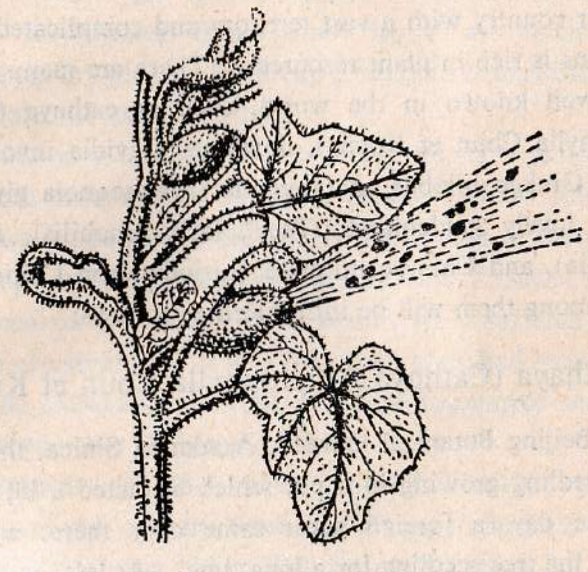

Fig. 68 Squirtingcucumber

CHAPTER IX

PRECIOUS PLANTS IN OUR COUNTRY

Our country with a vast territory and complicated natural conditions is rich in plant resources. There are many precious plants well known in the world, such as cathaya (Cathaya argyrophylla Chun et Kuang), dovetree (Davidia involucrata), ginkgo (Ginkgo biloba), matasequoia (Matasequoia glyptostroboides), lovely goldenlarch (Pseudolarix amobilis), taiwania (Taiwania), and Chinese tuliptree (Liriodendron Chinese) etc. A few among them will be introduced as follows:

1 Cathaya (Cathaya Argyrophylla Chun et Kuang)

In Beijing Botanical Garden, Academia Sinica, there was a tree seedling growing in a pot which attracted a lot of visitors. One day, a foreign guest came over there, who had watched the tree seedling for a long time. At last, he asked in a gentle tone whether he could exchange a plane for it. However, the request was politely refused. Why is the seedling so precious? What kind of tree is it? It is called cathaya (Cathaya argyrophylla Chun et Kuang).

Cathaya (Fig. 69) belongs to gymnosperm*. It is a big evergreen tree. It has a strong trunk with 17 — 19 meters in

height and its crown is like an umbrella. The bark is dark-green Its leaves take the shape of flattened similar to the shape of fir, but the arrangement of leaves is different, they are scattered threads on branches. The upper surface of leaves is green and bright with slight concave at the midrib. On lower surface there are two silver stomatal bands. When the sun hangs in the sky and is shining over the dense leaves, they glitter like silver. That is why it is so named. Cathaya is a monoecious plant. Its spherical flowers and "fruits" are much the same with those of pines. So plant taxonomists classified it with pines into the same family.

Cathaya is an old species among plants. It appeared in the earth earlier than the giant panda. About sixty million years ago, these trees were widely distributed in the continents of Europe and Asia. However, as a result of glacier movement happened on the earth, the beautiful trees suffered from the danger of extinction. For a long time, they had been considered to be extinguished. The scientists recognized and investigated them only from their fossils.

Nevertheless, the miracle happened. In 1956, the famous botanist of our country, Professor Zhong Jixin first found the species which was either like fir or like pine in Yuecheng mountain near Guilin, Guangxi Province. Through careful identification in 1958, the taxonomists named it Cathaya argyrophylla Chun et Kuang. Its finding caused a sensation in

* Gymnosperm in morphology is different from the green flowering plant described above. It has ovules without the envelope of ovary, so the seeds produced are naked.

the circle of botanists, so it was listed into one of new titbits in the twentieth century. Now it has been clearly demonstrated that the cathaya exists in the mountains of Sichuan, Yunnan, Guizhou, and Hunan provinces besides Guangxi. According to the analysis by scientists, cathaya can survive in these regions is mainly because of the high mountains and varied topographies which were little influenced by glacier.

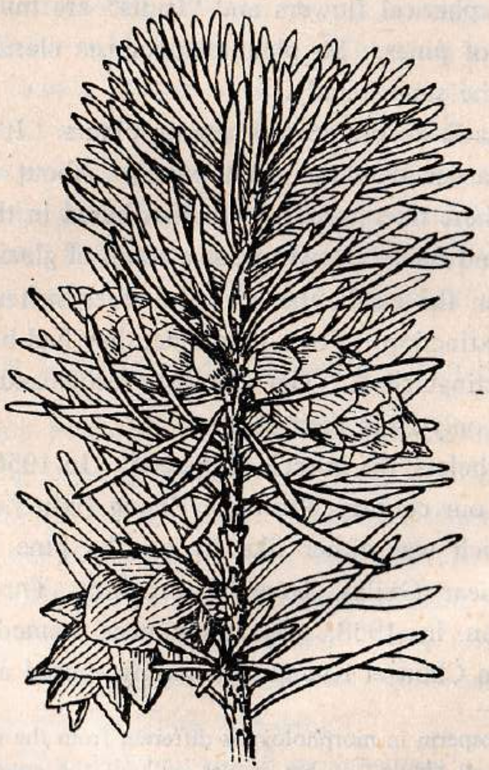

Fig. 69 Cathaya (Cathaya argyrophylla Chun et Kuang)

Cathaya argyrophylla Chun et Kuang is a special plant or endemic species of our country. Its preciousness lies in its very slow growth rate and great difficulty in reproduction besides its rareness. It takes 2 — 3 hundred years to grow a tree with 10 meters high. If one takes its seed to sow or its twig to transplant, it also fails to survive. The botanists in Beijing Botanical Garden have exerted all their efforts to cultivate the seedling mentioned above! As it is a peculiar and precious species of our country, so people praise it as the "giant panda" in plant kingdom.

2 Dovetree (Davidia Involucrata)

Dovetree is also named white pigeon tree (Fig. 70). It is said that Wang Zhaojun, a famous lady in Han dynasty (206 B.C.—A.D. 220) went beyond the Great Wall and married Hu Han Xie Chanyu. She settled down over there and missed her hometown day and night. In order to find sustenance for her homesickness, she wrote a lot of letters and let the white pigeons deliver them for her. The lovely pigeons speeded across the sky to her remote home — Zigui County, Hubei Province. Thousands of white carrier pigeons perched on dovetrees, and became a great deal of white flowers. Although this is a fairy tale that was made up for her deeds of devoting herself to her nation, the beautiful dovetree flowers are, indeed, much like the white pigeons resting on the tree branches.

Dovetree is a deciduous tree with about 30 meters in height. The diameter of breast height (d.b.h.) (about 1.3 meters above the ground) is more than 1 meter. It is mainly

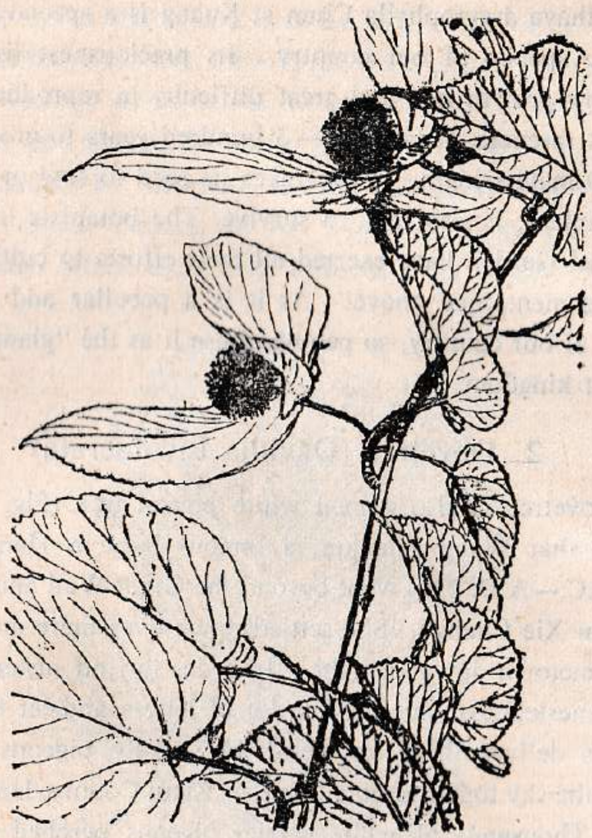

Fig. 70 Dovetree (Davidia involucrata)

distributed in Hubei, Sichuan, Hunan, Yunnan and Guizhou provinces of our country. The tree blossoms from April to May each year. The flowers are very unique as compared with those of other plants. Outside the flower there are two big metamorphic leaves called bracts. Originally, the bracts are light green, later, they drop down. In the center of the two

bracts there is a purplish-red globular structure which is composed of a number of male flowers and a hermaphroditic flower that arrange orderly into an inflorescence called capitulum. The fresh green leaf is smooth on the upper surface and has short soft silky hairs on the lower surface. This plant can either be propagated with seeds, or by cutting. Particularly, they have a strong ability to develop new twigs from the stem near the ground. After the trunk is torn, the rhizomes will give out new plants.

In the very early days, dovetree was widely distributed, but 20 — 30 thousand years ago, the heavy attack on the forests by the glacier in quaternary period made them largely destroyed. However, due to the high mountains standing in great numbers, and the varied topographies appearing in some provinces of Southeast China, the dovetree in local areas escaped from the great calamity and survived so far. According to the data concerned, in 1869, a French priest first found the dovetree in Muping region (now Baoxing County). It was not until 1900, when the botanist Wilson sent by British Horticultural Company, came to our country for an investigation, he collected the seeds, and sent them back for propagation. After that, the dovetree left its motherland far away and resided in Europe. Now it is an important garden tree in Europe, also an ornamental one well known in the world.

3 Ginkgo (Ginkgo Biloba)

If you have the opportunity to go to the temples of Dajue,

Tanzhe and Wofo etc. in Beijing for a sightseeing, you may see the old and strong ginkgo trees among the buddhist temples (Fig. 71). It is said that in Dajue temple there is an old ginkgo tree planted in Liao dynasty and is more than one thousand years old. It has about 3 meters in d.b.h. Ginkgo tree is regarded as "Holy tree" by buddhist monks and nuns because of its tall, strong and majestic appearance. So they were

Fig. 71 Ginkgo (Ginkgo biloba)

most planted in temples in the old days. Ginkgo is seldom attacked by diseases. It possesses a strong capability of resistance to air pollution by smoke and poisonous gases. Now it is a plant species making green in some cities of our country.

Ginkgo also belongs to gymnosperms. It is a tall tree too. Its crown is beautiful with jade green leaves, each of which looks like a folded fan. In autumn, the green leaves turn into yellow, showing a magnificent autumn scenery. Ginkgo is dieocious. All the "flowers" are located at the tips of the short branches. Male "flowers" are spikelike. In spring, pollen grains scatter out and fly with wind for the female plants to pollinate. The female "flowers" grow in clusters, each of which has a long stalk carrying a pair of ovules. During September and October, in the branches of female plant hang the seeds which are green at early stage, then turn yellow. The ginkgo seed is much like an apricot in shape and morphological structure, but they are different in essence. The yellow succulent part of ginkgo is not caro, but is specialized exotesta. After the outer skin is peeled off or decayed, the kernel left is called "white fruit". Therefore, ginkgo is also named "white fruit tree". The kernel may be used as food and Chinese medicine as well. If it is taken raw, it functions as detoxificating and asthma curing medicine. If it is eaten cooked, it may profit lungs. However, it is a little bit poisonous, so one cannot eat too much. The ginkgo tree grows and develops very slowly. It is said that the tree planted by grandfather will bear "fruit" at the time when his grandson grows up. Therefore, it is also known as "grandfather-grandson tree".

In the past, some botanists in Europe mistakenly considered that ginkgo originated from Japan. In fact, it originally appeared in deep valleys of Tianmu Mountain in Zhejiang Province of China. Investigation has confirmed that ginkgo plants appeared on the earth more than two hundred million years ago. Later, also because of the crustal movement and the drastic changes in climate, they were gradually on the wane and tended to extinct. Anyway, ginkgo trees in the deep valleys of west mountain of Tianmu in our country found a suitable place to make their home and their preservation was richly endowed over there by nature.

4 Metasequoia (Metasequoia Glyptostroboides)

If you walk in front of the Hall of Lamarck in Beijing Zoo, or in the green area of Ying Taogou at Western Fragrant Hills, you may see a kind of tree which, on the one hand, is similar to fir, on the other hand, is similar to cypress. This is another precious plant in our country — metasequoia (Fig. 72). Its trunk may reach about 35 meters high and 2.5 meters in d.b.h. If we take a careful observation, it looks to be closer to fir. Metasequoia is a kind of scenic trees which is highly recommended. Therefore, it had not been a "rare guest" who resided in European botanical garden long ago. At present, there are more than fifty countries in the world introducing this species. In our country they are widely planted.

Metasequoia also belongs to gymnosperms. It is a big deciduous tree as ginkgo. Its lateral branches are situated in the directions of east-west and south-north alternatively. The

Fig. 72 Metasequoia (Metasequoia glyptotroboides)

upper branches are shorter than the lower ones, so the crown looks much like a pagoda. The leaves are linear and flat arranging in two rows, left and right, on small branches. So the small branches with leaves look like a dark green comb very much. When winter comes, the leaves and small branches fall with wind. Metasequoia is monoecious. The spherical male flowers are oppositely located on the nodes of branches. The spherical female flower grows singlely at the tip of the small branch. The seed with wings will be produced after pollination of the female flower. The seed is very small with only 5 milimeters in length. The tree is a rapid growing one which increases annually 1 meter in height under good conditions. Its wood, with light and soft properties, can be used to make houses, furniture and paper etc. Metasequoia met with the same misfortune as cathaya, ginkgo. About one hundred million years ago, its family was widely distributed in the Northern Hemisphere near the Arctic Circle. Later, due to the crustal movement and the change in climate from hot to cold etc., it was forcely migrated into Europe, North America and North of Asia. About 1—2 million years ago, the glacier came in, and metasequoia with a large scale of forests was destroyed altogether, only a few were fortunate to be maintained in the mountain valleys of Sichuan and Hubei provinces in China.

Forty years have passed since the finding of metasequoia in 1941, the forestry scientist of our country — Professor Yu Duo found an unusually big tree in front of the temple at Modaoqi district, Wanxian County, Sichuan Province when he passed there. It was severe winter, there was no way to identify its

naked branches. Through inquiring about the tree, he knew that it loves water, even can be immersed in water all the year round and growing normally. The tree in front of the old temple Modaoqi mentioned above, evoked tremendous interest of the botanists in our country. Through the efforts for several years, more than one thousand of the same plants were found on the border between Hubei and Sichuan provinces. The scientists collected certain specimens and studied them, finally, they identified the tree and named it metasequoia in 1946.